An Operations and Support Model for SEER-H

Advanced modeling tools that help engineers, managers and cost analysts plan and control critical projects.

SEER™

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Overview

The O&S Approach In SEER-H

How O&S Estimation Folds Into Knowledge Based Estimation

Describing O&S Scenarios

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Full Integrated Life Cycle Costing

The SEER-H Operations & Support model is fully integrated with development and production estimates

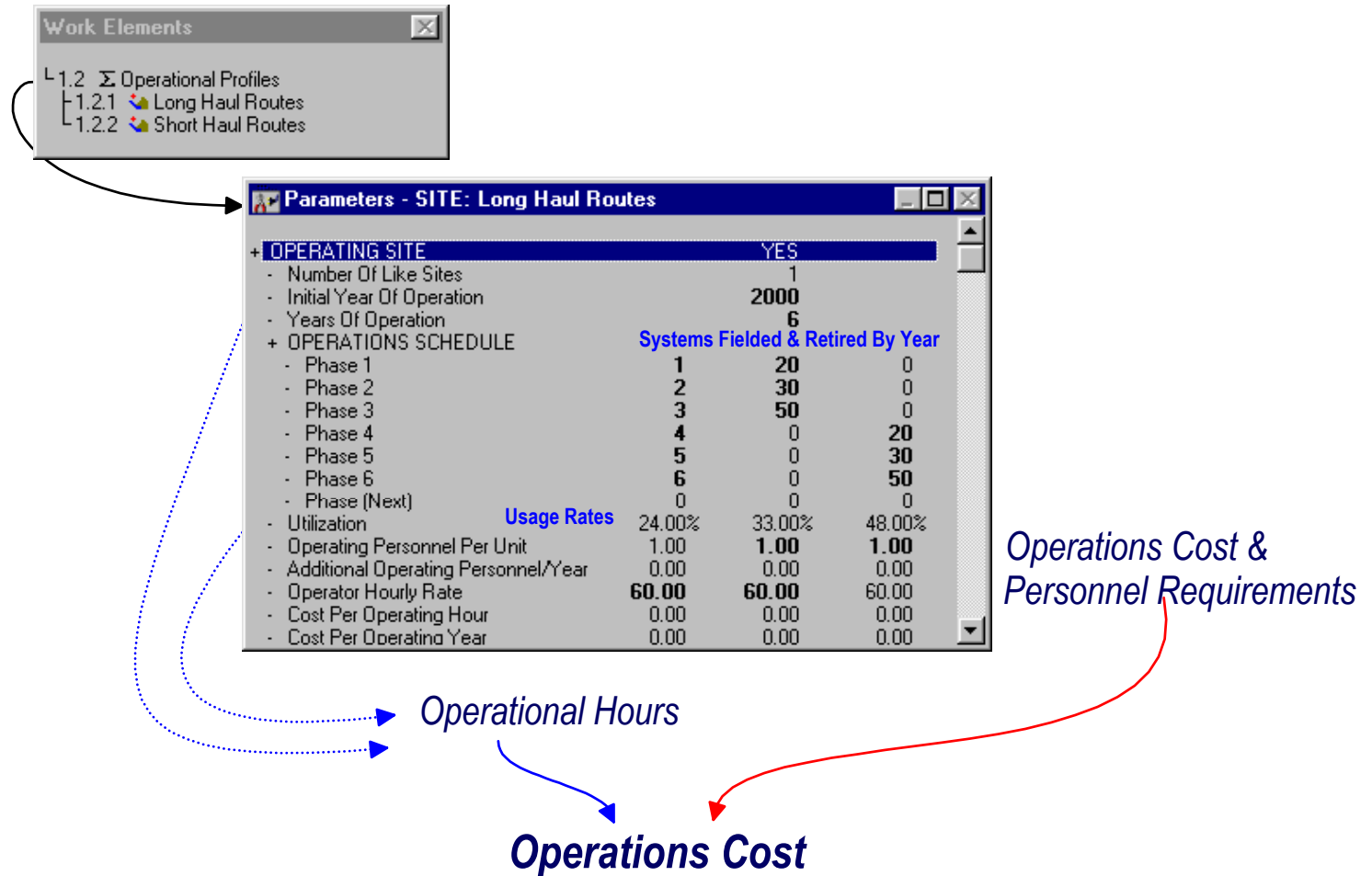## FX-222 Estimate Baseline: Life Cycle Cost Allocation

- Development (11.5%)
- Production (20.2%)
- Operating Site (59.7%)
- Total Equipment Support (8.7%)

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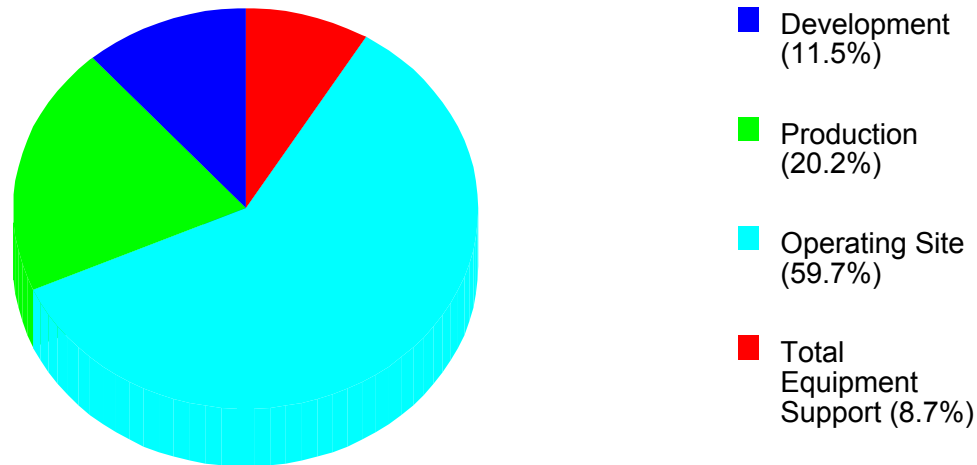
A "Baseline" Flexible, Dynamic Model Allows Modeler To Set Assumptions
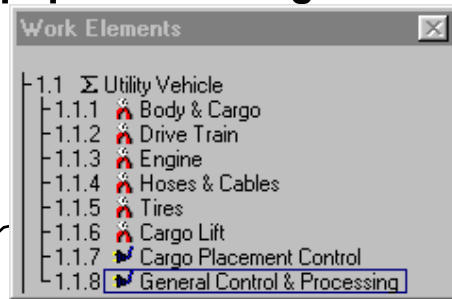
Dynamic modeling of fielding, maintenance, support

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Modeling Operations Cost

Concept Of Operations

Work Elements

- 1.2 Σ Operational Profiles
  - 1.2.1 Long Haul Routes
  - 1.2.2 Short Haul Routes

Parameters - SITE: Long Haul Routes

OPERATING SITE		YES	
- Number Of Like Sites		1	
- Initial Year Of Operation		**2000**	
- Years Of Operation		**6**	
+ OPERATIONS SCHEDULE		**Systems Fielded & Retired By Year**	
- Phase 1	**1**	**20**	0
- Phase 2	**2**	**30**	0
- Phase 3	**3**	**50**	0
- Phase 4	**4**	0	**20**
- Phase 5	**5**	0	**30**
- Phase 6	**6**	0	**50**
- Phase (Next)	0	0	0
- Utilization	**Usage Rates** 24.00%	33.00%	48.00%
- Operating Personnel Per Unit	1.00	**1.00**	1.00
- Additional Operating Personnel/Year	0.00	0.00	0.00
- Operator Hourly Rate	**60.00**	**60.00**	60.00
- Cost Per Operating Hour	0.00	0.00	0.00
- Cost Per Operating Year	0.00	0.00	0.00

Operational Hours

Operations Cost & Personnel Requirements

Operations Cost

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Modeling Support Cost

Equipment Configuration

Work Elements

- 1.1 Σ Utility Vehicle
  - 1.1.1 Body & Cargo
  - 1.1.2 Drive Train
  - 1.1.3 Engine
  - 1.1.4 Hoses & Cables
  - 1.1.5 Tires
  - 1.1.6 Cargo Lift
  - 1.1.7 Cargo Placement Control
  - 1.1.8 General Control & Processing

Support Concept

Parameters - MECH: Cargo Lift

		YES	
+ LEVEL 1 SUPPORT		YES	
- Consumable Cost Per Repair	0.00	0.00	0.00
- In Place Repair Rate	0.01%	0.01%	0.01%
- Remove & Replace Time (hours)	1.50	3.00	6.00
- MTTR (hours)	**0.00**	**0.00**	**0.00**
- Condemnation Rate	1.00%	2.00%	3.00%
+ LEVEL 2 SUPPORT		NO	
+ LEVEL 3 SUPPORT		YES	
- Consumable Cost Per Repair	0.00	0.00	0.00
- <<MTTR (hours)>>	10.08	10.08	10.08
- Condemnation Rate	1.00%	1.00%	2.00%
+ Level 3 Support Activity by Site			
- Regional Repair Contractor	100.00%		

Maintenance Activity by Level

Equipment Description

Parameters - MECH: Cargo Lift

+ EQUIPMENT INFORMATION			
- Usage Rate	100.00%	100.00%	100.00%
- <<Mature MTBF (hours)>>	3,224	3,224	3,224
- Scheduled Maintenance Cycle (hours)	80	150	200
- <<Operating Hours to Mature MTBF>>	94	94	94
- Spares Availability		90.00%	
- Spares Lead Time (hours)	72	336	1,008
- <<Equipment Replacement Cost>>	1,830.22	1,830.22	1,830.22
- <<Equipment Material Cost>>	469.20	469.20	469.20
- Retirement Cost Per Unit	0.00	0.00	0.00
- Packing/Shipping Factor	1.10	1.20	1.30
+ Quantity By Operational Site			
- <<Short Haul Routes>>	1	0	
- <<Long Haul Routes>>	1	0	

Reliabilty

Support Cost

Maintenance Demand Rate

Equipment Specific Deployment

Operational Hours

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O&S Model Concept of Operation: Interacting Hardware & Site Elements

Operations-only site

Multiple-site fielding

Interaction between levels 1, 2 and 3 support

Electrical and mechanical hardware

Single-site fielding

Operating and support site

Spares...

Support-only site
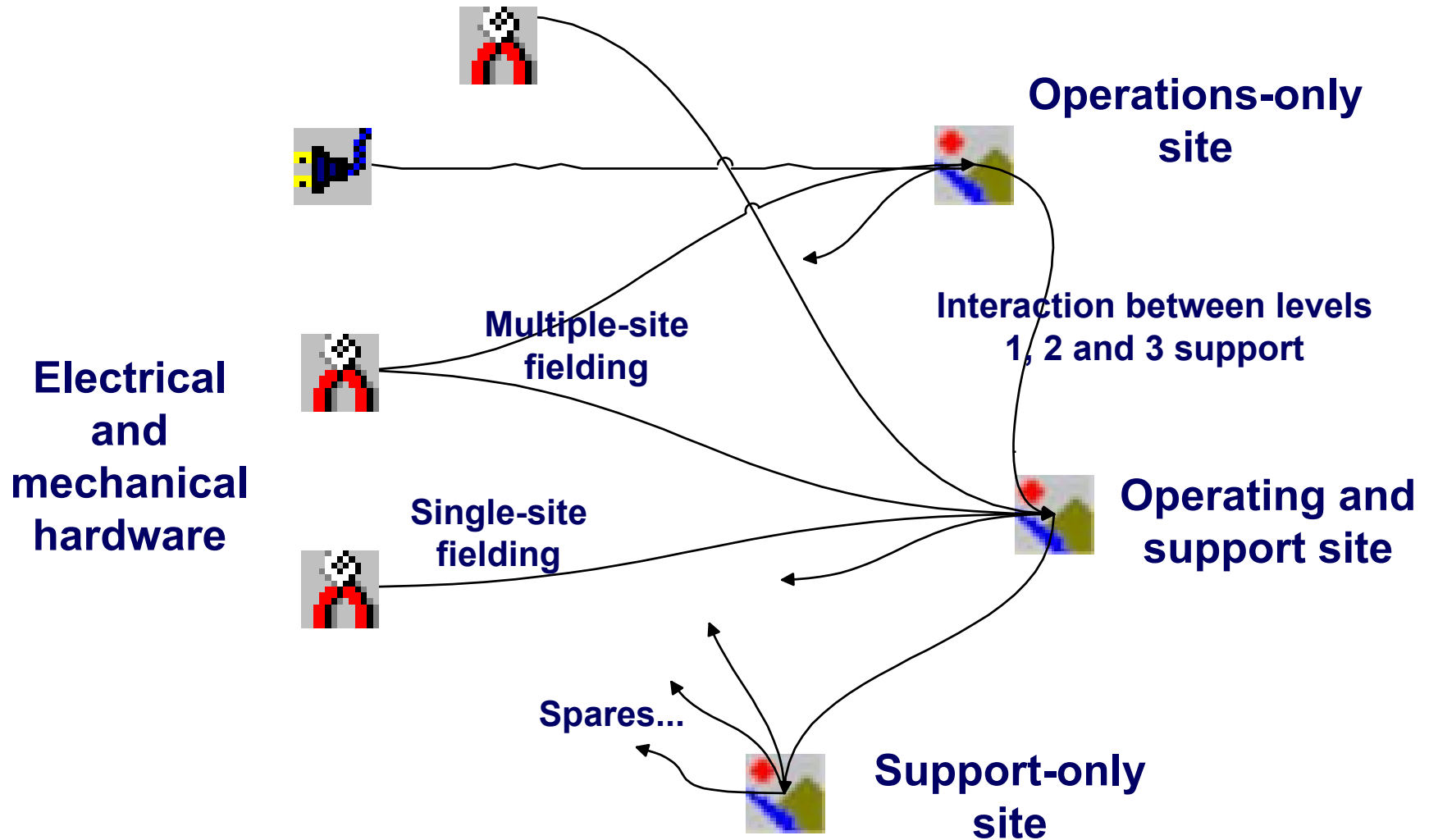
Electrical and mechanical hardware elements.   **Site elements.**

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More On The "Site" Element...

Capturing A <u>Logical</u> Rather Than <u>Physical</u> Entity

"Site" elements can be used to separately capture many distinguishing characteristics. They can be combined for a multi-faceted representation of the same physical location!

1 site element for a single "location"...

OR...

Many elements for a single location...
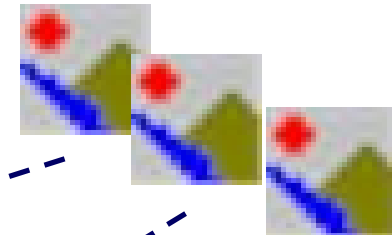
All systems fielded at the site have uniform characteristics. An element can also represent many identical "sites".

Equipment use

At a particular site, you can capture and isolate differences in...

Support arrangements over time

Specific components of O&S costs

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SEER-H with O&S Supports TOC

SEER-H TOC Is Based On 4 Major Cost Components...

Each Cost Component Possesses Its Own Drivers

All Components Are Interdependent

Development Cost
**+ Production Cost**
+ Operations Cost
+ Support Cost

Total Ownership Cost

Life Cycle Cost Allocation

Radar Site: Life Cycle Cost Allocation

- Development (13.9%)
- Production (25.5%)
- Operating Site (37.8%)
- Total Equipment Support (22.8%)

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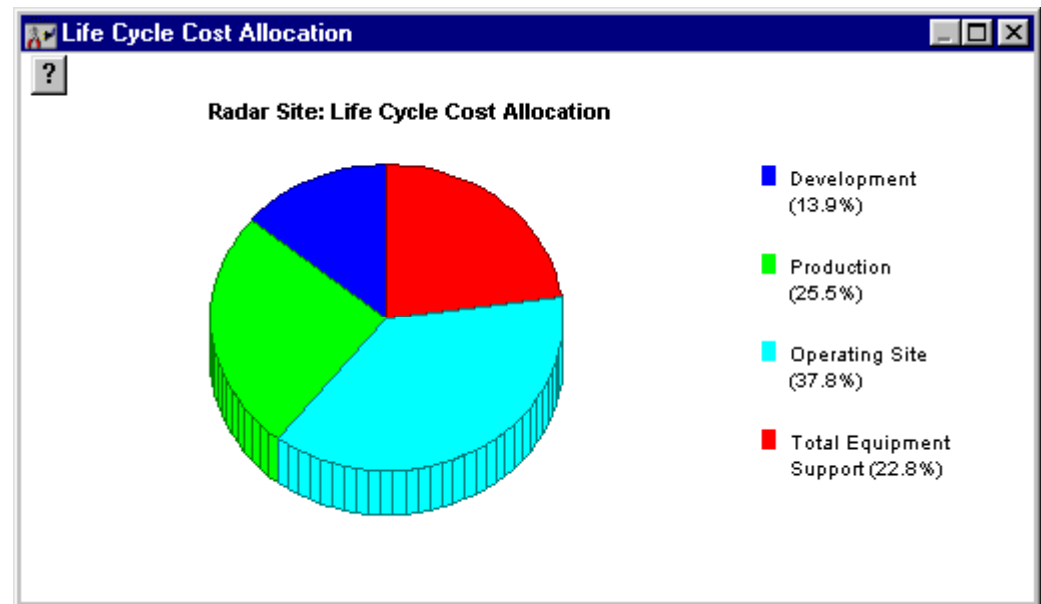
Identifying Cost Drivers

Life Cycle Cost Comparison

Family: Digital Processing

Work Element #
- 1.1.2.1
- 1.1.2.2
- 1.1.2.3
- 1.1.2.4
- 1.1.2.5
- 1.1.2.6

Legend:
- ■ Dev
- ■ Prod
- ■ OpSite

High cost system elements are easily identified

and detail further evaluated

Detail Labor and Material Estimate

Production Labor By Category

Development Labor By Category

Detail Operations and Support

SUMMARY	6,062,364	
Support Labor	3,642,952	60.09%
Spares	1,010,770	16.67%
Parts	726,318	11.98%
Consumables	0	0.00%
Other Support	682,324	11.26%

COST OF OWNERSHIP METRICS

Years Of Operation	20
Equipment Operating Hours	30,434,553
Avg Operating Hours per Yr	1,521,728
Avg Support Cost per Yr	303,118
Avg Support Cost per Equipment Hr	0.20
Life Cycle Cost per Equipment Hr	0.24

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Knowledge-Based Approach

- **The core SEER-H O&S model uses traditional dynamic modeling techniques.**

- **Key drivers can be determined by knowledge base settings:**
  - Support cost drivers
    - **MTBF, MTTR, Ophours To Maturity, Spares Cost, etc.**
  - Operations & support characteristics
    - **Usage Rates, Personnel Requirements, Labor Rates, etc.**

- **Knowledge-based life-cycle cost estimates allow for:**
  - Life-cycle cost estimates at very early conceptual stages
  - Immediate TOC evaluation of design alternatives

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Knowledge-Based Estimates Embody Risk

Ranges in knowledge based estimates...

...Are used to evaluate O&S cost risk

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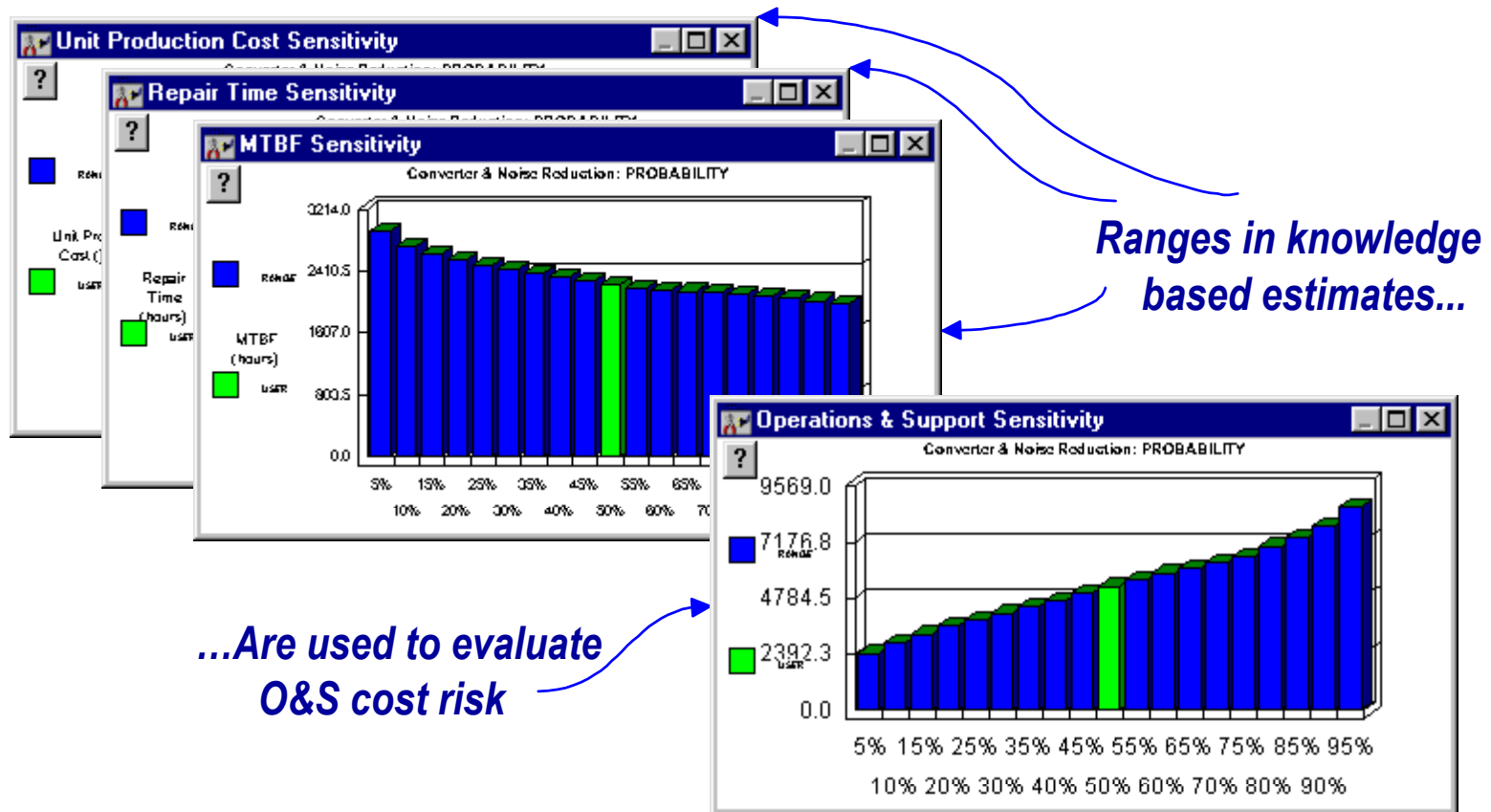
Example... Technology Upgrade of An Embedded Computer

Before

Parameters - ELEC: Computer			
+ PRODUCT DESCRIPTION			
- Total Printed Circuit Boards	1.00	3.00	4.00
+ CIRCUITRY COMPOSITION			
- Percent Analog	0.00%	0.00%	0.00%
- Percent Digital	80.00%	95.00%	100.00%
- Percent Hybrid		00%	10.00%
- Discrete Components Per PCB		48	75
- Surface Mount Discretes		00%	45.00%
- Integrated Circuits Per PCB	15		40
- Surface Mount ICs	25.00%	35.00%	40.00%
- Input/Output Pins Per PCB	95	230	
- Clock Speed (MHz)	100.00	150.00	300.00
- Packaging Density	Nom	Nom	Nom+
- IC Technology	Nom+	Hi	Hi+
- Custom Chip Usage	Nom	Nom	Nom

After

Parameters - ELEC: Computer			
+ PRODUCT DESCRIPTION			
- Total Printed Circuit Boards	1.00	1.00	2.00
+ CIRCUITRY COMPOSITION			
- Percent Analog	0.00%	0.00%	0.00%
- Percent Digital	80.00%	95.00%	100.00%
- Percent Hybrid	0.01%	5.00%	10.00%
- Discrete Components Per PCB	35	48	75
- Surface Mount Discretes	100.00%	100.00%	100.00%
- Integrated Circuits Per PC	8	10	12
- Surface Mount ICs	00.00%	100.00%	100.00%
- Input/Output Pins Per PCB	120	120	120
- Clock Speed (MHz)	300.00	300.00	300.00
- Packaging Density	Hi-	Hi	Hi+
- IC Technology	VHi	VHi	VHi
- Custom Chip Usage	VHi	VHi	EHi-

Reduced component count increased MTBF, reduced support cost

Use of ASICs increased NRE and parts costs

Quick Estimate

Base Year: 1998 Database: seer-

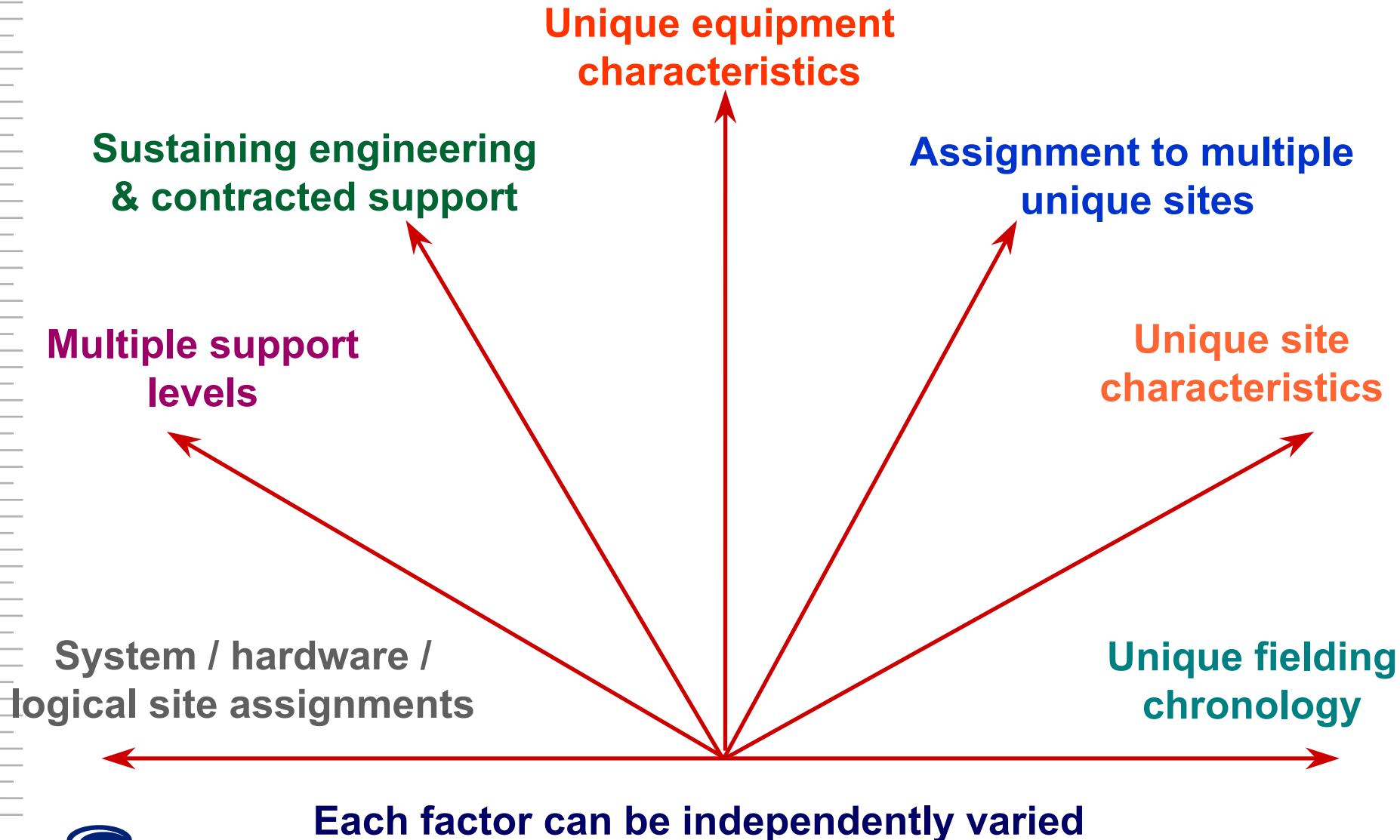|	Result	Reference	
DEVELOPMENT			
Development Cost	455,886	354,595	29%
TOTAL PRODUCTION			
Production Cost	130,367	144,413	-9%
Total Production Units	25	25	0%
AVERAGE PRODUCTION UNIT COST (APUC)			
APUC	5,214.70	5,776.51	-9%
OTHER			
MTBF (Hours)	8,735	2,799	212%
Life Cycle Cost (Cost of Ownership)	794,549	751,643	6%
OPERATIONS & SUPPORT			
Total Equipment Support Cost	208,296	252,635	-17%
Support Labor Hours	1,362	2,602	-47%
Support Labor Cost	57,034	108,376	-46%
Other Support Cost	9,980	21,251	-52%
Spares	6	7	-13%
Spares Cost	31,288	40,436	-22%
Parts and Consumable Cost	109,994	82,573	33%
Equipment Operating Hours	922,603	922,603	0%

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Demonstration of SEER-H With O&S Model

Please see Conference CD for a fully animated demonstration

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Multiple Degrees of Freedom for Highly Flexible O&S Modeling

Unique equipment characteristics

Sustaining engineering & contracted support

Assignment to multiple unique sites

Multiple support levels

Unique site characteristics

System / hardware / logical site assignments

Unique fielding chronology

Each factor can be independently varied

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Sample Trade Studies

◆ **What happens if the failure rate is decreased?**

◆ **Should a repair strategy be carried out at the system level, or should there be unique strategies for sub-components?**

◆ **How many tiers of maintenance should there be?**

◆ **Which sites should maintenance be focused at?**

◆ **What happens when fielding is accelerated?**

◆ **Can spares on hand be reduced at the outset of operations?**

◆ **How will changes in equipment utilization change costs?**

◆ **Can contracted support be substituted for organic support?**

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SEER-H O&S Modeling Flowchart

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Thanks For Coming!

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